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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Denis BABIN
Title: VALVE GATE ASSEMBLY FOR
INJECTION MOLDING
Appl. No.: 09/944,109
Filing Date: 09/04/2001
Examiner: Unassigned
Art Unit: 1722

CLAIM FOR CONVENTION PRIORITY

Commissioner for Patents
Washington, D.C. 20231

Sir:

The benefit of the filing date of the following prior foreign application filed in the following foreign country is hereby requested, and the right of priority provided in 35 U.S.C. § 119 is hereby claimed.

In support of this claim, filed herewith is a certified copy of said original foreign application:

- Canadian Patent Application No. 2,317,779 filed 09/06/2000.

Respectfully submitted,

Date NOV 13 2001

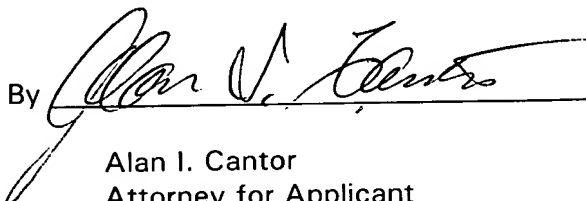
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the Patent Office.

Specification and Drawings, as originally filed, with Application for Patent Serial No:
2,317,779, on September 6, 2000, by **MOLD-MASTERS LIMITED**, assignee of
Denis Babin, for "Valve Gate Assembly for Injection Molding".

Gracy Paulhus
Agent certificateur/Certifying Officer

September 10, 2001

Date:

Canada

(CIPO 68)
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ABSTRACT OF THE DISCLOSURE

A valve pin assembly for an injection molding apparatus is disclosed comprising a valve pin capable of movement up and down in a nozzle to open and close a ring gate. An annular passage is created through the nozzle and
5 is unobstructed and without restriction at all points up to and through the ring gate, permitting melt to flow freely to the gate and, depending on the position of the valve pin, into the mold cavity. The valve pin has a head with a diameter larger than the valve pin shaft for selectively closing the gate. The ring gate channel diameter is larger than the melt channel diameter to permit parts with
10 large apertures therein to be formed.

BP # 10984-70

BERESKIN & PARR

Canada

Title: VALVE GATE ASSEMBLY FOR INJECTION MOLDING

Inventor: Denis Babin

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Title: VALVE GATE ASSEMBLY FOR INJECTION MOLDING**FIELD OF THE INVENTION**

This invention relates generally to the injection molding of articles with an aperture therein and, more particularly, to an improved gating
 5 apparatus for injection molding articles having large apertures.

BACKGROUND

Injection molding can be used advantageously to mold plastic articles of all shapes and description. Among such articles are those having a aperture therethrough, typically centrally located, such as in an audio
 10 compact disc or a lamp shade, or the like. Various apparatuses are known in the art for accomplishing such articles, as shown in U.S. Patent Nos. 4,368,028 to Grish et al., 4,530,654 to Rose and 5,423,672 to Gordon and Japanese Patent No. JP10-16005, each of which is incorporated herein by reference. These references disclose an injection molding apparatus having
 15 a nozzle with a central valve pin therein, creating an annular passage for melt to flow therearound to a gated tip. The valve pin permits the flow of melt to be positively selectively controlled and, when extended from the nozzle, also causes an annular ring 'gate' form between the pin and the nozzle tip, thereby permitting an annular article to be formed having a central aperture
 20 therethrough.

The apparatus of Grish et al., Rose, Gordon and/or JP10-16005, however, do not facilitate the forming of plastic articles having a large diameter apertures (such as a lamp shade), primarily for several reasons. Firstly, if the inner bore of the nozzle is enlarged to facilitate molding a the
 25 larger diameter aperture, a greater volume of melt will remain in the nozzle after each cycle, thereby increasing the risk of melt degradation in the nozzle and increasing the difficulty in controlling the overall temperature of the melt. Also, guiding the valve pin can become a problem. U.S. Patent No. 4,340,353 to Mayer, incorporated herein by reference, teaches a plurality of radially

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outwardly and angularly spaced extending arms 76 and 78 used to guide a valve stem 74. These arms, however, together with flow opening 89 represent obstructions of the incoming flow of molten resin, toward the mold cavity, which generate several melt or flow lines in the finished product, decreasing
 5 the overall attractiveness of the product.

A possible solution to the problem of reducing melt volume in the nozzle is to increase the pin diameter correspondingly to reduce the overall volume of melt in the nozzle. If the pin diameter is so increased, however, the melt is exposed to an increased overall surface area in the
 10 nozzle which results increased pressure losses in the runner system.

The prior art also proposes splitting or otherwise distributing the melt prior to delivery to the gate and injection into the mold cavity. For example, U.S. Patent No. 5,324,190 to Frei, incorporated herein by reference, discloses the use of a plurality of borings 19 through the nozzle which break
 15 up the flow in the resin, as do the spacers 17. Similarly, U.S. Patent No. 5,460,763 to Asai, also incorporated herein by reference, discloses a plurality of passages 21 for distributing the flow in the nozzle. In U.S. Patent No. 4,394,117 to Taylor, incorporated herein by reference, though a central valve pin is not used, this reference does disclose a resin passage 55 which
 20 terminates in a conical dispersion head 66 mounted on its lower portion and a sleeve valve 30 fitted slidably cooperating to selectively prevents the molten material from flowing into the mold cavity.

The devices of Frei, Asai and Taylor, however, can also result in the appearance of flow lines in the final product. To combat this problem,
 25 U.S. Patent Nos. 5,784,234 and 5,840,231, both to Teng and incorporated herein by reference, disclose an even more complex apparatus to recombine the individual streams of molten resin after they are split and prior to entering the cavity gate, so as to minimize the appearance of flow lines. The apparatuses of Frei, Asai, Taylor and Teng, however, all require careful
 30 machining and make a resin colour change a laborious and time consuming proposition, as the intricate surfaces must be carefully cleaned before a new

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colour resin can be introduced.

Therefore it is desirable to provide an apparatus which permits improved control of the flow plastic melt from a hot runner system to a plurality of cavities to achieve more uniformity of formed articles. It is also desirable to
 5 avoid restrictions to or interferences with melt flow through the nozzle to permit the cavity to be filled with a uniform melt and receive a high quality product particularly for articles with large apertures therethrough.

SUMMARY OF THE INVENTION

In one aspect, the present invention provides an injection
 10 molding apparatus comprising:

at least one mold cavity formed between a cavity plate and a core, the cavity plate and the core matable along a parting line;

at least one injection molding nozzle having a gate, the at least
 one injection molding nozzle connectable to a source of molten material and
 15 capable of feeding molten material from the source to the gate through at least one melt channel through the nozzle, the gate communicating with the at least one mold cavity, the melt channel having a diameter, the gate having a diameter larger than the melt channel diameter;

a valve pin disposed interior of the melt channel and the gate,
 20 the valve pin defining an unrestricted annular melt flow passage through the melt channel, the valve pin moveable between a first position, where the valve pin substantially contacts the gate sufficiently to stop a flow of molten material through the gate, and a second position, where molten material may flow unrestricted through the gate.

In a second aspect, the present invention provides an injection
 25 molding apparatus comprising:

at least one mold cavity formed between a cavity plate and a core, the cavity plate and the core matable along a parting line;

at least one injection molding nozzle having a gate, the at least
 30 one injection molding nozzle connectable to a source of molten material and

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capable of feeding molten material from the source to the gate through at least one melt channel through the nozzle, the gate communicating with the at least one mold cavity, the melt channel having a diameter, the gate having a diameter larger than the melt channel diameter;

5 a valve pin disposed interior of the melt channel and the gate, the valve pin defining an unobstructed annular melt flow passage through the melt channel, the valve pin moveable between a first position, where the valve pin substantially contacts the gate, and a second position, where molten material may flow unobstructed through the gate.

10 In a third aspect, the present invention provides an injection molding apparatus comprising:

at least one mold cavity formed between a cavity plate and a core, the cavity plate and the core movable along a parting line;

15 at least one injection molding nozzle having a gate, the at least one injection molding nozzle connectable to a source of molten material and capable of feeding molten material from the source to the gate through at least one melt channel through the nozzle, the gate communicating with the at least one mold cavity, the melt channel having a diameter, the gate having a diameter larger than the melt channel diameter;

20 a valve pin disposed interior of the melt channel and the gate, the valve pin defining an annular melt flow passage through the melt channel and the gate, the molten material being capable of a substantially unidirectional flow through the melt flow passage, the valve pin moveable between a first position, where the valve pin substantially contacts the gate
25 sufficiently to stop a flow of molten material through the gate, and a second position, where molten material may flow through the gate.

In a fourth aspect, the present invention provides an injection molding apparatus comprising:

30 at least one mold cavity formed between a cavity plate and a core, the cavity plate and the core movable along a parting line;

at least one injection molding nozzle having a gate, the at least

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one injection molding nozzle connectable to a source of molten material and capable of feeding molten material from the source to the gate through at least one melt channel through the nozzle, the gate communicating with the at least one mold cavity, the melt channel having a diameter, the gate having a
 5 diameter larger than the melt channel diameter;

a valve pin disposed interior of the melt channel and the gate, the valve pin defining an annular melt flow passage through the melt channel and the gate, the melt flow passage having an effective cross-section transverse to direction of flow therethrough which is equal to or greater than
 10 the effective cross-section of any upstream location in the passage, the valve pin moveable between a first position, where the valve pin substantially contacts the gate sufficiently to stop a flow of molten material through the gate, and a second position, where molten material may flow through the gate.

15 In a fifth aspect, the present invention provides an injection molding apparatus to form articles having a hole comprising:

a mold having of a cavity plate and a core, the cavity plate and the core matable at a parting line and defining a mold cavity space therebetween;

20 an injection molding nozzle having a melt channel therethrough, the melt channel in communication with a gate;

a valve pin disposed interior of the melt channel, the valve pin and the melt channel define an unrestricted annular melt flow passage, the valve pin having a first portion of a diameter D1 and a second portion of a
 25 larger diameter D2; and

an actuator linked to the first portion of the valve pin to move the valve pin in a first position towards the mold gate and to a second position backwards from the mold gate to seal the communication between the nozzle and the mold cavity space.

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BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made by way of example to the accompanying drawings. The drawings show articles made according to a preferred embodiment of the present invention, in which:

Figure 1 is a sectional side view of an injection molding apparatus according to the present invention;

Figure 2 is an enlarged partial view of the apparatus of Figure 1 at circle A, the apparatus being shown in the "closed" position;

Figure 3 is an enlarged view similar to Figure 2, showing the apparatus in an intermediate position;

Figure 4 is an enlarged view similar to Figure 2, showing the apparatus in the "open" position; and

Figure 5 is a sectional side view of a core and molded article, namely a lamp shade, in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An injection molding apparatus according to the present invention is shown generally in the Figures at M. Apparatus M comprises a nozzle mold plate 20 and a cavity plate 13 cooperating with a mold core 10 along a parting line PL to form a mold cavity 11 therebetween. An injection molding machine (not shown) has an injection nozzle (not shown) which communicates with a heated runner system 30 via a sprue bushing 32 to provide molten plastic therethrough, under pressure. A locating ring 21 is provided to position the molding machine. Runner system 30 communicates through an inlet sleeve or body 17 with an annular melt channel 12 centrally located in an injection nozzle 7. Injection nozzle 7 has a nozzle head 15 and is positioned in a nozzle plate 6 positioned substantially in cavity plate 13. Runner system 30 is maintained at a desired operating temperature by inlet body heater elements 16, nozzle heater elements 14 and a thermocouple 9 communicating with a suitable control system (not shown), as is well known

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in the art. Centrally disposed in melt channel 12 of nozzle 7 is a valve pin 1 which is axially movable in nozzle 7, for reasons described in more detail below, by the cooperation of an activating cylinder 19 (which may be pneumatic or hydraulic, as is well known in the art), and a rack and pinion transfer activating gear 18.

Referring to Figure 2, valve pin 1 has a stem 1', a neck 4, a plate or head 2 and a guiding lug or spigot 3. A removable nozzle tip 8 and a nozzle plate 6 cooperate with neck 4 and head 2 to selectively connect melt channel 12 with mold cavity 11 depending on the position of valve pin 1, as will be described in more detail below. A spigot notch or bore 5 is provided in core 10 for receiving and guiding valve spigot 3. Spigot bore 5 has a shoulder 34 for receiving valve head 2, and a core sleeve space 23 is present between shoulder 34 and head 2 when valve 1 is in any position other than the "open" position, as will be described below. A core sleeve 22 surrounds core sleeve space 23 to prevent melt from penetrating therein.

Nozzle tip 8 has an enlarged opening 36 in the mold end thereof which cooperates with valve pin 1 to create a nozzle tip gate 24 therebetween. Melt channel 12 communicates with opening 36 via a substantially smooth transition zone 38.

Valve 1, valve stem 1', valve head 2, melt channel 12, transition 38 and opening 36 are substantially circular in cross-section so as to give melt channel 12 an annular shape (between valve 1 and nozzle 7) and give gate 24 an annular entry into mold cavity 11. Valve stem 1' has an outside diameter D_1 and head 2 has an outside diameter D_2 , while melt channel 12 has a diameter of M_1 and opening 36 has an inside diameter M_2 . As can be seen from Figure 2, head 2 diameter D_2 is slightly less than opening 36 diameter M_2 to permit head 2 to be inserted into opening 36 to close gate 24, as will be described in more detail below.

When in the "closed" position, as shown in Figure 2, head 2 is positioned so as to substantially contact tip 8 at opening 36 to close gate 24.

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Pressurized melt in runner system 30 is thus prevented from entering mold cavity 11. In this position, core sleeve space 23 has a height of Δ_2 , as shown.

Referring again to Figure 1, as will be understood by one skilled in the art, cylinder 19 may be selectively actuated and controlled by an appropriate system (not shown) to activate rack and pinion gear 18 to effect an axial movement of valve pin 1 within nozzle 7. From the "closed" position (Figure 2), cylinder 19, when driven, advances valve pin 1 axially in nozzle 7 through an intermediate position (Figure 3) to a fully "open" position (Figure 4).

Referring to Figure 4, when valve pin 1 is in the "open" position, valve pin 1 has moved axially away from nozzle tip 8, so that gate 24 is opened between head 2 and opening 36. Gate 24 thus provides a passage for heated melt to pass from melt channel 12 in nozzle 7 and into cavity 11, in response to pressure from the injection molding machine (not shown). In the intermediate position (Figure 3), core sleeve space 23 has a height of Δ_1 , but in the fully "open" position, there is essentially no core sleeve space at 23' (see Figure 4).

Referring to Figures 1 and 4, it will be apparent that runner system 30 is annular, unobstructed, unrestricted and continuous throughout melt channel 12, gate 24 and ultimately mold cavity 11. The melt flow path is annular and of never-decreasing cross-section (ie. transverse to the direction of flow therethrough) from the point of entry into nozzle 7 until the melt enters cavity 11, thereby yielding a simple flow path through which melt may freely flow when permitted to do so by the apparatus. This free-flow is advantageous because it assists in reducing pressure losses in the system and permits resin colour changes to be achieved more quickly in the apparatus.

The enlarged opening 36 and the cooperation of transition zone 38 and valve neck 4 advantageously permit a larger aperture ring gate 24 to be achieved than is possible with the prior art and without the need for the

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spreading or distribution means of the prior art, such as those shown variously in U.S. Patent Nos. 4,340,353 to Mayer, 5,324,190 to Frei, 5,460,763 to Asai, 4,394,117 to Taylor, No. 5,784,234 to Teng and 5,840,231 to Teng, each of which is incorporated herein by reference. None of these references
5 teach the use of a transition 38 and enlarged opening 36 to permit a relatively small diameter melt channel 12 to provide melt to a larger aperture part P, as a shown in Figure 5, while permitting the melt to free flow, in an unrestricted manner into the cavity, thereby permitting improved part quality.

Diameter M_2 of opening 36 is chosen according to the particular
10 application, as will be understood by one skilled in the art, and will be at least larger than diameter M_1 of melt bore 12 in order to achieve the benefit of an ability to mold larger aperture parts according to the present invention. As shown in the Figures, a diameter M_2 of much larger than M_1 is preferred, and a diameter M_2 of roughly the diameter of tip 8, or greater, is yet more
15 preferable.

One skilled in the art will understand that the present invention may be applied to single- or multi-cavity injection molds. One skilled in the art will understand that other modifications are possible. For example, the actuation of valve pin 1 and its movement from the "open" to "closed"
20 positions may be achieved by other known means. The use of a guide splgot 3 is desired but not necessary.

While the above description constitutes the preferred embodiment, it will be appreciated that the present invention is susceptible to modification and change without parting from the fair meaning of the proper
25 scope of the accompanying claims.

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CLAIM:

1. An Injection molding apparatus comprising:
 - (a) at least one mold cavity formed between a cavity plate and a core, said cavity plate and said core matable along a parting line;
 - 5 (b) at least one Injection molding nozzle having a gate, said at least one injection molding nozzle connectable to a source of molten material and capable of feeding molten material from said source to said gate through at least one melt channel through said nozzle, said gate communicating with said at least one mold cavity, said melt channel having a diameter, said gate
 - 10 having a diameter larger than said melt channel diameter;
 - (c) a valve pin disposed interior of said melt channel and said gate, said valve pin defining an unrestricted annular melt flow passage through said melt channel, said valve pin moveable between a first position, where said valve pin substantially contacts said gate sufficiently to stop a flow of
 - 15 molten material through said gate, and a second position, where molten material may flow unrestricted through said gate.

2. An injection molding apparatus comprising:
 - (a) at least one mold cavity formed between a cavity plate and a core, said cavity plate and said core matable along a parting line;
 - 20 (b) at least one injection molding nozzle having a gate, said at least one Injection molding nozzle connectable to a source of molten material and capable of feeding molten material from said source to said gate through at least one melt channel through said nozzle, said gate communicating with said at least one mold cavity, said melt channel having a diameter, said gate
 - 25 having a diameter larger than said melt channel diameter;
 - (c) a valve pin disposed interior of said melt channel and said gate, said valve pin defining an unobstructed annular melt flow passage through said melt channel, said valve pin moveable between a first position, where said valve pin substantially contacts said gate, and a second position, where

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molten material may flow unobstructed through said gate.

3. An injection molding apparatus comprising:

(a) at least one mold cavity formed between a cavity plate and a core, said cavity plate and said core matable along a parting line;

5 (b) at least one injection molding nozzle having a gate, said at least one injection molding nozzle connectable to a source of molten material and capable of feeding molten material from said source to said gate through at least one melt channel through said nozzle, said gate communicating with said at least one mold cavity, said melt channel having a diameter, said gate
10 having a diameter larger than said melt channel diameter;

(c) a valve pin disposed interior of said melt channel and said gate, said valve pin defining an annular melt flow passage through said melt channel and said gate, said molten material being capable of a substantially unidirectional flow through said melt flow passage, said valve pin moveable
15 between a first position, where said valve pin substantially contacts said gate sufficiently to stop a flow of molten material through said gate, and a second position, where molten material may flow through said gate.

4. An injection molding apparatus comprising:

(a) at least one mold cavity formed between a cavity plate and a core, said cavity plate and said core matable along a parting line;
20

(b) at least one injection molding nozzle having a gate, said at least one injection molding nozzle connectable to a source of molten material and capable of feeding molten material from said source to said gate through at least one melt channel through said nozzle, said gate communicating with
25 said at least one mold cavity, said melt channel having a diameter, said gate having a diameter larger than said melt channel diameter;

(c) a valve pin disposed interior of said melt channel and said gate, said valve pin defining an annular melt flow passage through said melt channel and said gate, said melt flow passage having an effective cross-

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section transverse to direction of flow therethrough which is equal to or greater than the effective cross-section of any upstream location in said passage, said valve pin moveable between a first position, where said valve pin substantially contacts said gate sufficiently to stop a flow of molten
 5 material through said gate, and a second position, where molten material may flow through said gate.

5. The apparatus of claim 1 wherein said the core further includes a core sleeve for engaging said valve pin.

6. The apparatus of claim 1 wherein said valve pin has a guiding spigot
 10 for guiding said valve pin between said first position and said second position.

7. The apparatus of claim 1 wherein said at least one nozzle includes a nozzle tip which is separable from said at least one nozzle, said gate being located in said nozzle tip.

15 8. An injection molding apparatus to form articles having a hole comprising:

(a) a mold having of a cavity plate and a core, said cavity plate and said core matable at a parting line and defining a mold cavity space therebetween;

20 (b) an injection molding nozzle having a melt channel therethrough, said melt channel in communication with a gate;

(c) a valve pin disposed interior of said melt channel, said valve pin and said melt channel define an unrestricted annular melt flow passage, said valve pin having a first portion of a diameter D1 and a second portion of a
 25 larger diameter D2; and

(d) an actuator linked to said first portion of the valve pin to move said valve pin in a first position towards the mold gate and to a second position

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backwards from the mold gate to seal the communication between the nozzle and the mold cavity space.

9. The apparatus of claim 1 wherein said melt channel has a diameter and said gate has a diameter, and wherein said gate diameter is larger than
5 said melt channel diameter.

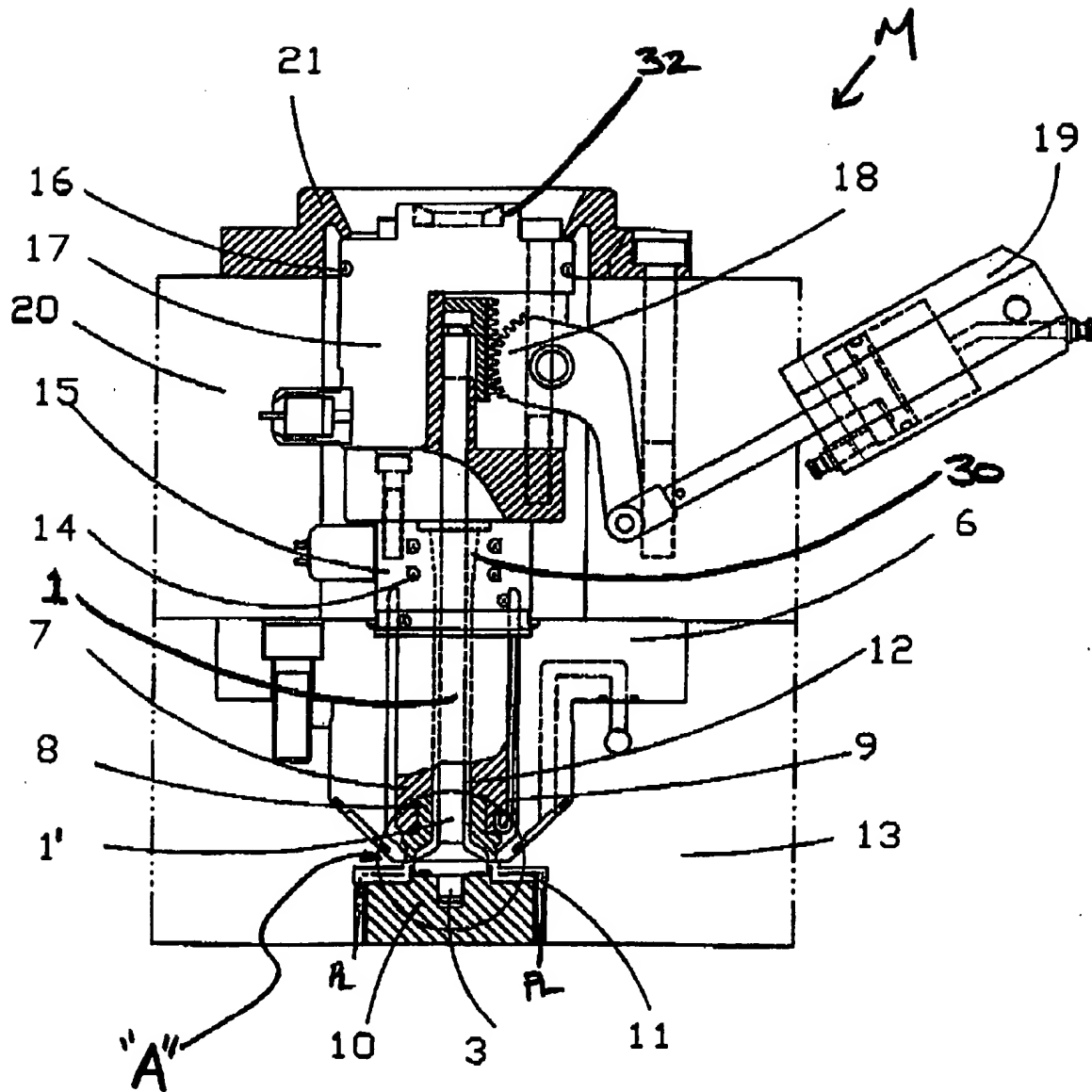


FIGURE 1

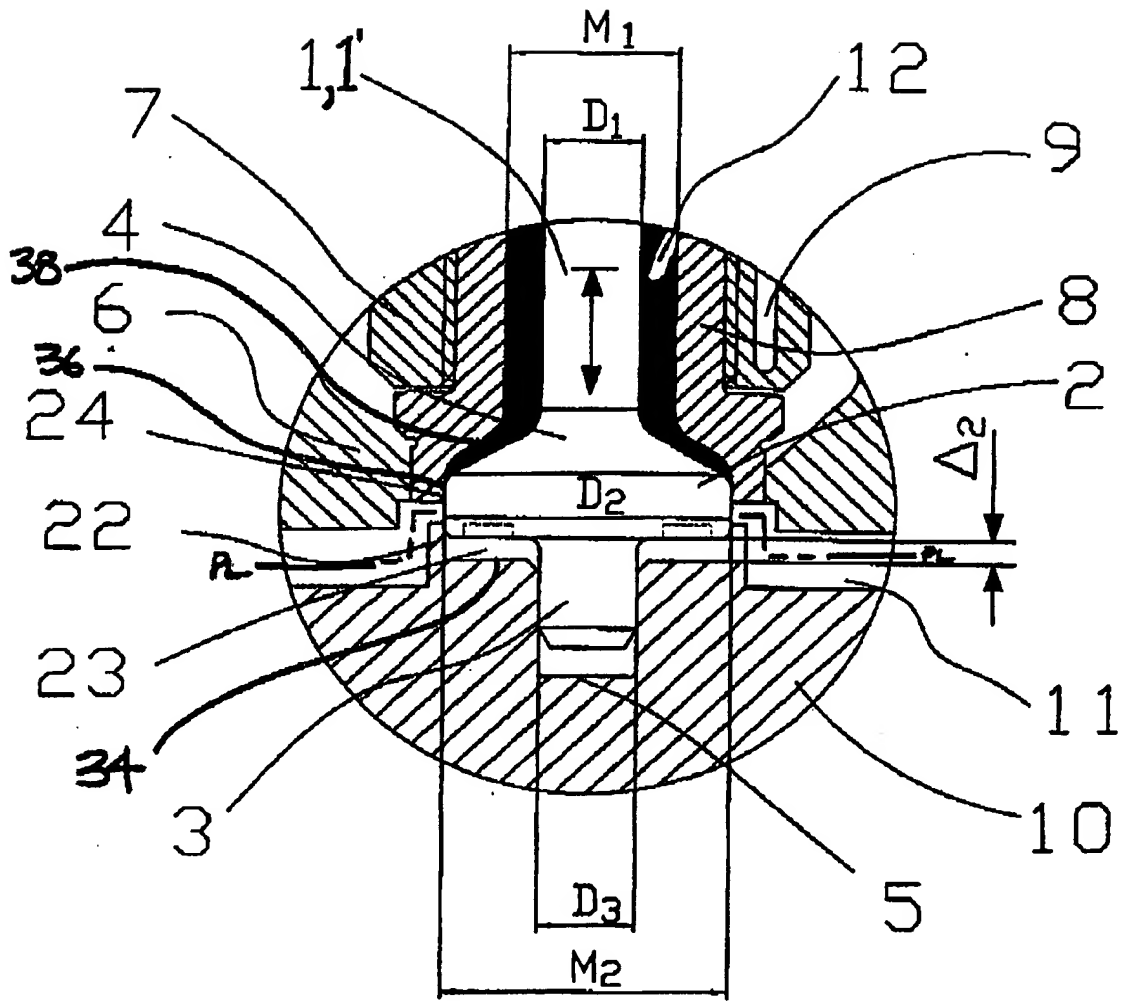


FIGURE 2

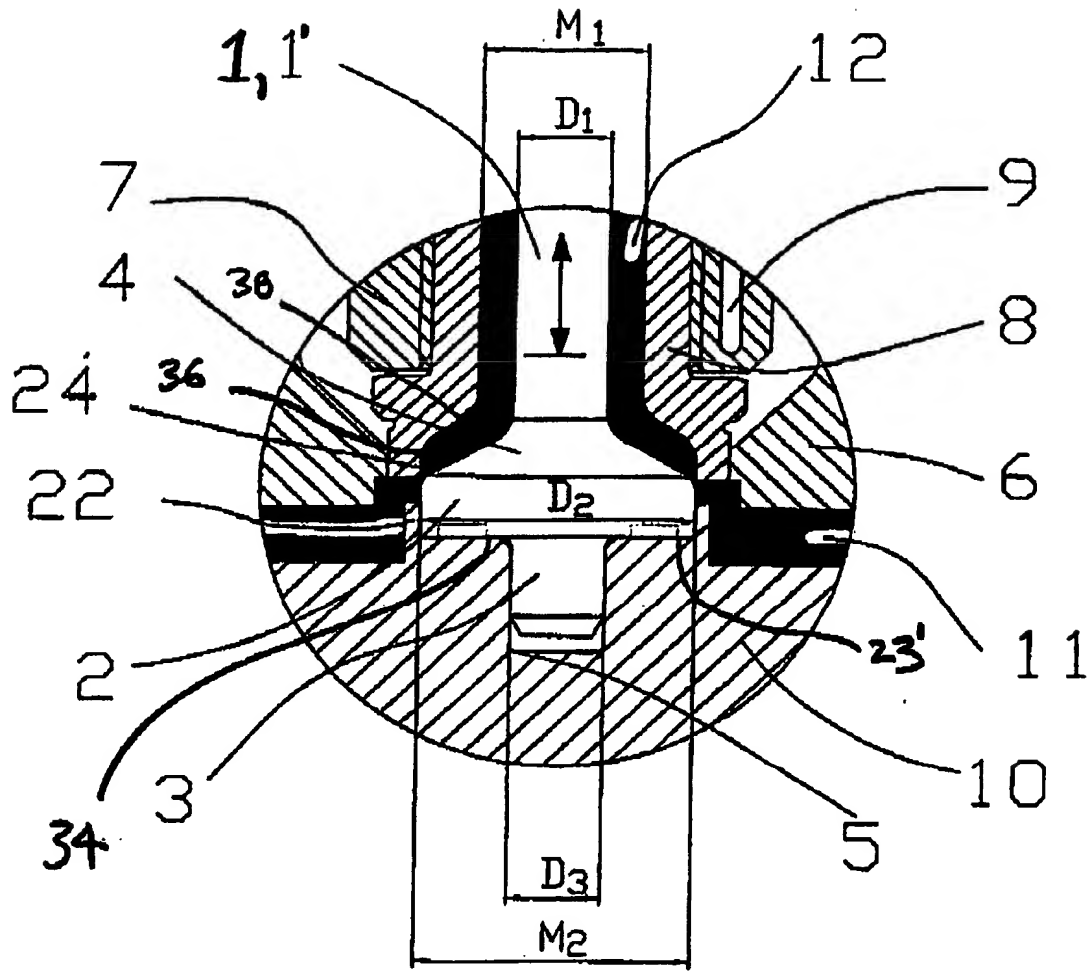


FIGURE 4